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ABSTRACT

This document presents the agreements on principles and goals for mathematics assessment reached at a meeting of persons representing various math education, public policy, business and industry and parent and community constituencies held at the National Academy of Sciences in spring, 1991. Sections of the document lay the groundwork for the establishment of the principles and goals by discussing the need for assessment reform in mathematics education, how assessment enhances the learning and teaching of mathematics, strategies for change, the vision of the National Council of Teachers of Mathematics described in "Curriculum and Evaluation Standards for School Mathematics," and the challenge for world-class mathematics education as presented by mathematics and education professor Shirley Hill and President George Bush. The following are principles agreed upon at the meeting: (1) the primary purpose of assessment is to improve learning and teaching; (2) the primary use of results of assessments is to promote the development of the talents of all people; and (3) the content of assessment is derived from the consensus of the discipline. The meeting set forth the following goals for the mathematics assessment of all students to be reached by the year 2000: (a) assessment aligned with needed mathematical knowledge, skills and processes; (b) assessment practices to promote the development of mathematical power; (c) effective assessment based on a variety of methods; (d) utilization of adequate accountability systems; (e) development of guidelines for judging the quality of mathematics assessments; (f) teacher and administrator proficiency in using a wide variety of assessment methods; and (g) a public informed about assessments and assessment practices. A list of participants is provided. (MDH)

FOR GOOD MEASURE

Principles and Goals for Mathematics Assessment

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A REPORT OF THE NATIONAL SUMMIT
ON MATHEMATICS ASSESSMENT

MATHEMATICAL SCIENCES EDUCATION BOARD

NATIONAL ACADEMY OF SCIENCES, NATIONAL ACADEMY OF ENGINEERING,
INSTITUTE OF MEDICINE, NATIONAL RESEARCH COUNCIL

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We at the Mathematical Sciences Education Board express our appreciation to the organizations that share our goal for strengthening U.S. mathematics education and that generously supported the National Summit on Mathematics Assessment.

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THE NATIONAL SUMMIT

For Good Measure presents the agreements on principles and goals for mathematics assessment reached at the National Summit on Mathematics Assessment on April 23-24, 1991, at the National Academy of Sciences in Washington, D.C. The principles and goals evolved from deliberations of 800 citizens representing various constituencies—mathematics education, the education and public policy sectors, the assessment industry, business and industry, and parent and community groups. The deliberations were conducted at four regional forums and at the national summit and through mail reviews of draft documents following the meetings.

These agreements form a foundation for the development of national standards for mathematics assessment—clearly formulated guidelines to assist teachers, schools, districts, states, and test developers in creating alternative assessments for mathematics. The principles and goals for mathematics assessment can also inform the current debate on a national system of examinations to measure progress in meeting the national goals for mathematics set by President Bush and the 50 governors.

I wish to thank President Bush for addressing the summit and for recognizing the progress of the mathematics education community in setting world-class standards for mathematics. I also wish to express gratitude to the Honorable Lamar Alexander, who gave generously of his time and expertise as Chairman of the Steering Committee for the National Summit on Mathematics Assessment. Secretary Alexander's visionary leadership made it possible for the Steering Committee to reach agreement on challenging issues of mathematics assessment and educational accountability.

I commend the members of the Steering Committee for their exemplary work. This was a committee of outstanding leaders from diverse educational, private sector, and public policy organizations who not only accomplished the task of building a foundation for assessment standards for mathematics, but who also laid a foundation for continued collaboration in pursuit of the national goals for mathematics and science education.

Building consensus on standards for mathematics assessment is a priority of the Mathematical Sciences Education Board and the National Research Council. I hope you will read these proceedings and join us in building an even broader base of consensus on this important issue.

Frank Press
President, National Academy of Sciences
Chairman, National Research Council

"This National Summit on Mathematics Assessment will help us all to understand the issues and launch a national effort to inform the American public about what it means to be first in the world in mathematics achievement and how we can know if we have accomplished that goal."

The Honorable Lamar Alexander
Secretary, U.S. Department of Education
Chairman, National Summit on Mathematics Assessment

The Need for Assessment Reform

National Need for Numeracy

Our nation's economic and social well-being demands that we have a population with greater thinking, reasoning, and learning skills in mathematics. For this reason, the mathematics education community is pursuing a coordinated and broad-based reform plan for school mathematics. Its key elements are new and more demanding standards for what is taught in mathematics and how it is taught.

These standards call for all students to develop mathematical power—the ability to use mathematics to solve nonroutine problems, to reason logically, and to communicate thoughts and ideas with the language of mathematics. If our students are to meet such standards, mathematics programs in our schools must expand to include much more than the traditional basic skills of arithmetic. They need to also focus on developing students' abilities to integrate, synthesize, and apply mathematical knowledge and data to solve complex problems.

"Assessment must measure what matters. We need to get beyond the mechanics. We need to gauge the ability to use the knowledge, not just the knowledge itself."

Ian Ross
President Emeritus,
AT&T Bell Laboratories

"We must ensure that tests measure what is of value, not just what is easy to test. What is tested is what gets taught. Tests must measure what is most important."

Everybody Counts
National Academy Press, 1989

"Numeracy is to mathematics as literacy is to language. Each represents a distinctive means of communication that is indispensable to civilized life. Despite great differences in structure and form, both mathematical language and natural language are powerful tools for description, communication, and representation. Numeracy is especially important for a nation expecting to compete in a global economy fueled by information technology."

Lynn Steen
Professor of Mathematics, St. Olaf College
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"Why we're here is to try to motivate and enable a nation to a higher level of achievement in education. We need to focus constantly on what happens in the classroom to the student. And we ought to devise an assessment that gets that job done."

The Honorable Roy Romer
Governor of Colorado
Chairman, National Education Goals Panel

Obstacles to Reform

Assessment—the process of collecting information for decision making—involves the use of a variety of data-producing instruments and techniques. Tests are just one means of assessment, but one that currently dominates educational decision making. Between 1972 and 1985, the number of mandated state testing programs grew from 1 to 34; by 1989 every state had some type of mandated testing program.

Public policy makers and school officials increasingly use test results to judge education. The high stakes now associated with test results have made test content a determining factor in what is taught in the nation's classrooms. Because today's tests largely measure computation and routine procedural skills, they are one of the greatest obstacles to mathematics education reform.

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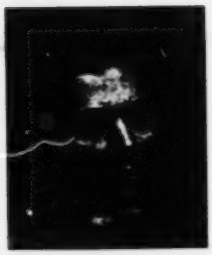
Assessment Enhances Learning and Teaching



"We have increasingly come to the conviction that if we are going to be where we want to be . . . in the year 2000, that we would be well served by establishing a set of national standards . . . and then allow individual states and school districts and schools to determine how they [are] going to teach their students in order to meet those standards."

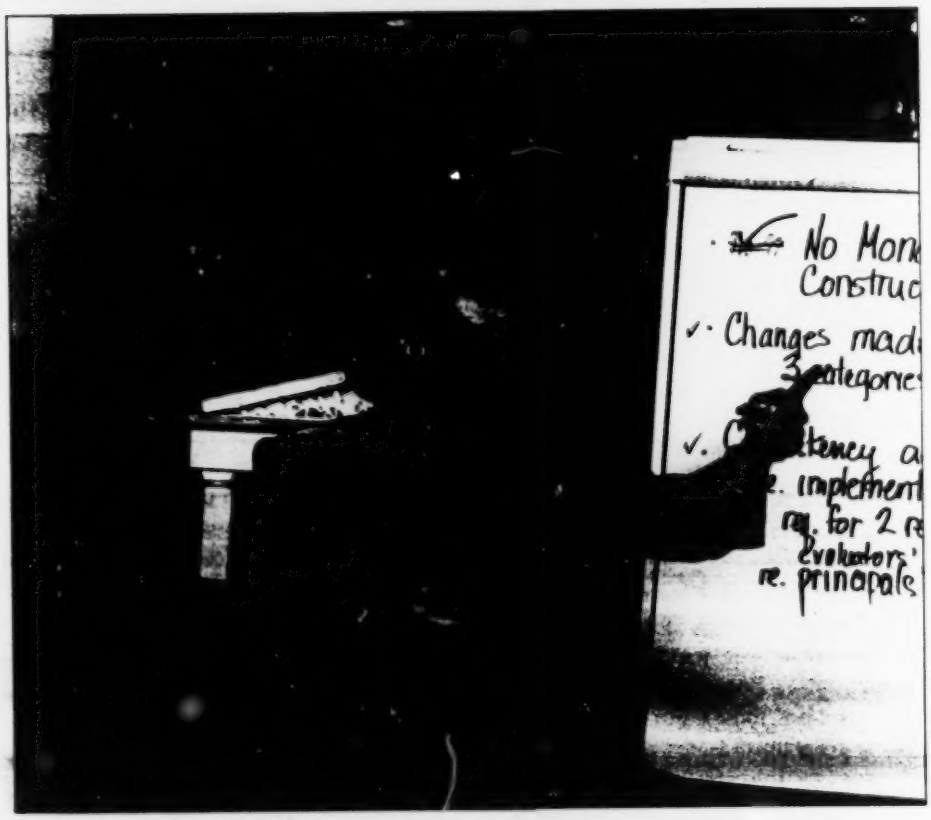
The Honorable Roger Porter
Assistant to the President for Economic and Domestic Affairs

Teachers Want Better Assessments

Mathematics teachers and educators want to remove the obstacle presented by current tests — not by eliminating tests but by improving them and expanding the ways in which mathematics education and mathematics achievement are assessed. Mathematics teachers want to be held accountable to the new and demanding standards they have set for themselves and their students.

The complex mathematics skills we expect of our students cannot be adequately assessed with only paper-and-pencil short-answer or multiple-choice tests. Teachers need to assess students' actual performance in doing mathematics—individually and in groups—solving problems, reasoning, communicating, and connecting mathematical ideas to each other and to real situations.

The performances and products of students provide rich and highly detailed information about their strengths and weaknesses that test scores alone cannot provide. With this kind of information, teachers can evaluate the effectiveness of their teaching strategies and make better informed instructional decisions. In this way, assessment greatly enhances the learning and teaching process.



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BEYOND ROUTINE SKILLS

Assessments that do not measure what is valued are of no use to teachers and students or to school officials and public policy makers responsible for education. Consequently, assessments must be aligned with the mathematics our students need to know and be able to do, and assessment alternatives to traditional short-answer and multiple-choice tests must be available to measure progress in pursuit of the new and demanding standards for school mathematics.

DEMANDING STANDARDS REQUIRE DIFFERENT ASSESSMENTS

Not just this . . .

What percent of 500 is 30?

A. 6%
B. $16.\bar{6}\%$
C. 60%
D. $166.\bar{6}\%$
E. none of the above

But also this . . .

THE BUDGET DEBATE

The Facts:

In 1980 the education budget of a certain community was $30 million out of a total budget of $500 million. In 1981 the education budget of the same community was $35 million out of a total budget of $605 million. The inflation rate for that one year period was 10%.

The Tasks:

1. Use the facts to argue that the education budget increased from 1980 to 1981.

2. Use the facts to argue that the education budget declined from 1980 to 1981.

"Multiple-choice tests are appropriate for certain purposes . . . but I think we've been locked into a mechanism whereby multiple-choice tests have been the only vehicle . . . and I think that has restricted the curriculum, particularly in this accountability environment."

JoAnn Lenke
Executive Vice President, The Psychological Corporation

Strategy for Change

"We are impressed that out of all of education today, mathematics, linked with science, is the one that has its act together."

The Honorable Mark Hatfield
U.S. Senator, Oregon

Climate for Change

America is awakening to the critical role that education plays in the future economic health and social well-being of our nation. Our people are our greatest resource—and all of them must be educated to participate productively in a global economy and society.

A decade of increasing concern for education culminated in 1990 with the establishment of national goals for education—an historic first for a nation philosophically committed to a decentralized system of education. This event marked the beginning of a move into unchartered territory, paving a new road for education that balances national interests with local jurisdiction.

National Standards—Local Implementation

Perhaps more historic than the national education goals themselves is the legitimacy the process of setting goals has given to the concept of national standards for education. Notwithstanding our regional variations and cultural diversities, there are common standards of excellence that all of our students need to meet.

The viability of a strategy of national standards with local implementation has been demonstrated by the recent reform efforts of the mathematics education community. The key to setting national standards for school mathematics that localities are voluntarily embracing and using as guides to local reform has been the involvement and consensus of all constituency groups with stakes in mathematics education.

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Building Consensus on National Standards

Effective reform of school mathematics requires professional, political, and public consensus on three issues:

- curriculum—the mathematics that young people should know and be able to do;
- instruction—how to present mathematics to them; and
- assessment—how to measure results.

The mathematics education community has used an augmented grass-roots strategy for the development of standards and for building consensus for them. Building on the creative work of many teachers, schools, and projects around the country, the mathematics education leadership drafted initial standards for curriculum and instruction that were widely disseminated for a year of public review. The review included mathematics teachers and educators, professional education organizations, business and industry, and parent and community groups. Based on the extensive input, the mathematics education leadership revised the standards to reflect the consensus of the constituencies involved.

"We need to understand from you what appropriate standards of assessment are. And although this may not be the most dramatic work in the crusade to reform our educational system, nothing else will happen without the work that you are doing here this week."

The Honorable Joseph Lieberman
U.S. Senator, Connecticut

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Standards for School Mathematics

Curriculum and Instruction Standards

Consensus-based national standards for curriculum that specify what mathematics students should know and be able to do are described in *Curriculum and Evaluation Standards for School Mathematics*, published by the National Council of Teachers of Mathematics (NCTM). The mathematics community has also developed national professional standards for teachers that describe what every teacher must know and be able to do to teach mathematics. These standards are contained in *Professional Standards for Teaching Mathematics*, published by NCTM and in *A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics*, published by the Mathematical Association of America.

Together, the curriculum and instruction standards for school mathematics portray the learning and teaching of mathematics that must take place in classrooms across America if the nation is to realize its goals for world-class mathematics programs. The fundamental restructuring of curriculum and instruction that these standards imply are most easily described as changes in expectations for students and teachers.

Assessment Standards

Recognizing that neither curriculum nor instruction could change in America's classrooms without concurrent change in assessment practices, the NCTM included in its *Curriculum and Evaluation Standards for School Mathematics* standards for evaluating both student performance and curricula. These standards address classroom assessment—assessment that serves the information needs of individual students and their parents and teachers.

Assessment standards are also needed to guide a wide variety of constituencies on external assessment—assessment that serves the accountability information needs of school administrators, policy makers, and the public. The mathematics education community will expand its evaluation standards into a more encompassing set of assessment standards to guide external assessment as well as classroom assessment.

■ ■ ■

From Arithmetic Competency to Mathematical Power

The mathematics community's view of its curriculum and teaching standards has been characterized in *Counting on You*, a publication of the Mathematical Sciences Education Board, as follows:

Goals for student performance are shifting from a narrow focus on routine skills to development of broad-based mathematical power.

Broad-based mathematical power refers to students' ability to:

- discern relationships;
- reason logically; and
- use a range of mathematical methods to solve a wide variety of nonroutine problems.

The repertoire of skills that now undergird mathematical power include not only some traditional paper-and-pencil skills but also many more powerful capabilities. For example, all students must be able to:

- make decisions based on the collection, representation, and interpretation of real data;
- use tables, graphs, spreadsheets, and statistical techniques to organize,

interpret, and present numerical information;

- judge the validity of mathematical and technical information presented by the media and others;
- use computer software for mathematical tasks;
- perform mental calculations and estimates with proficiency; and
- estimate orders of magnitude to confirm mental or calculator results.

Teaching as Intellectual Coaching

Goals for teacher performance are shifting from authoritarian models based on "transmission of knowledge" and "drill and practice" to student-centered methods featuring "stimulation of learning" and "active exploration."

The familiar classrooms of passive students who are expected to absorb rules that appear as arbitrary dicta are gradually giving way to learning environments that:

- encourage students to explore;
- help students to verbalize their mathematical ideas;
- show students that many mathematical questions have more that one right answer;
- teach students, through experience, the importance of careful reasoning and disciplined understanding;
- provide evidence that mathematics is alive and exciting; and
- build confidence in all children that they can learn mathematics.

The most useful metaphor for describing the modern teacher is that of an intellectual coach. At various times, this will require that the teacher be:

- a **role model** who demonstrates not just multiple paths to a solution but also the false starts, the higher-order thinking skills, and the effort that leads to the solution of problems;
- a **consultant** who helps individuals, small groups, or the whole class to decide if their work is "on track" and making reasonable progress;
- a **moderator** who poses questions to consider but leaves much of the decision making to the student, working individually or in groups;
- an **interlocutor** who supports students during class presentations, encouraging them to reflect on their activities and to explore mathematics on their own; and
- a **questioner** who challenges students to make sure that what they are doing is reasonable and purposeful and ensures that students can defend their conclusions.

■ ■ ■

"The [NCTM] Standards ensure that we will be world class . . . if only we can mobilize the population to expect excellence for all of its youth and to support all of its teachers in mathematics."

Iris Carl
President, National Council of Teachers of Mathematics

Alternatives in Mathematics Assessments

"You've talking about empowering and enabling teachers to use assessment not just for the statewide issues, but day-to-day . . . I think that's an investment that we should make anyway."

Frank Newman
President, Education Commission of the States

Alternative Assessments Needed

When public expectations of students were limited to developing computational skills and mastering routine mathematical procedures, a learning environment that emphasized rote and other passive learning behaviors sufficed. Conventional multiple-choice tests that require students to perform simple calculations and replicate previously memorized procedures were adequate.

Our expectations now are for students to be able to reason logically and to integrate, synthesize, and apply mathematical knowledge and skill to solve complex problems. Thus, conventional multiple-choice tests are inadequate as the sole means for assessment. Our methods of assessing student achievement in mathematics must be expanded to include judging of student products and performance such as:

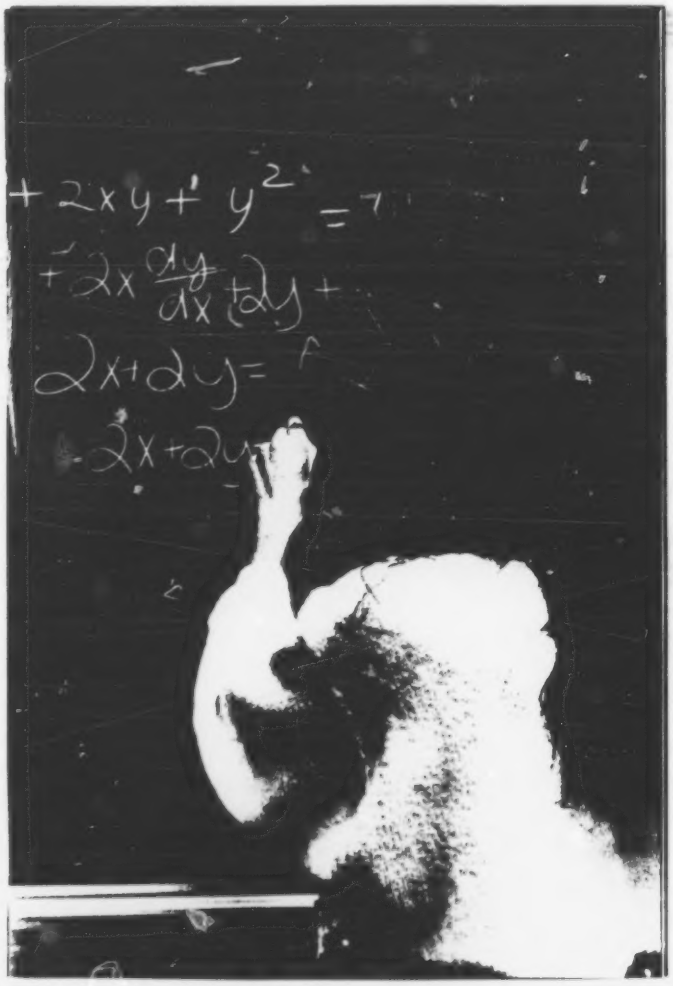
- responses to open-ended questions, problems, and tasks;
- projects;
- portfolios of mathematical products;
- writings;
- demonstrations, including computer demonstrations;
- presentations, discussions, and debates;
- investigations; and
- models and simulations.

Standards-Referenced Assessments

Assessment information about how well a student performs in relation to valued knowledge, skills, and processes—**standards-referenced assessment**—is needed more than information about how well a student performs in relation to other students—**norm-referenced assessment.**

Moving beyond assessments that merely sort, classify, rank, or select, we need mathematics assessments that:

- promote the development of mathematical power for all students;
- measure the full range of mathematical knowledge, skills, and processes specified by the NCTM curriculum standards; and
- communicate to students, parents, and teachers what mathematics students already know, as well as the mathematics they have yet to learn.



Summit Participants Reach Agreements

"Assessment needs are shifting from single numerical descriptors of minimum skills achievement to multiple descriptors of performance across a wide range of mathematical skills and processes."

Mary Harley Kruter
Director, National Summit on Mathematics Assessment

To accomplish the changes needed in mathematics assessment, mathematics educators joined with representatives of the public policy sector and the assessment industry in common cause. A Steering Committee chaired by the Honorable Lamar Alexander spent eight months studying assessment issues in mathematics education. The committee sought the counsel of national and international experts in mathematics assessment. It also sought the advice and experience of practitioners, parents, state and local public policy makers, and business and industry leaders in four regional forums across the nation.

The steering committee presented its findings to the 500 summit participants, who deliberated during the national convocation, reviewed draft documents following the summit, and built consensus around a statement of principles and goals for mathematics assessment. These agreements form the foundation for the development of national standards for mathematics assessment.

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The Vision: World-Class Mathematics Education for Achieving the Nation's Goals

"Listen to your teachers, America."

Shirley Hill
Curator's Professor of Mathematics and Education
University of Missouri—Kansas City

Excerpts of Summit Address by Shirley Hill

We have a remarkable opportunity to make real and sustainable change in education . . . created by the convergence of a number of factors, all of which may be necessary conditions for deep and lasting change, none of which is by itself sufficient. We have the public's attention and genuine concern about a world class education for their children. We have national goals for education, broadly supported. We have an emerging consensus about the efficacy of standards that all schools and students can strive to meet. We have numerous alliances and coalitions and diverse constituencies working together toward common objectives. We are learning at last to cooperate and coordinate our efforts. We have the immense potential of national leadership from the President and the Secretary of Education.

Mathematics education is ready for this opportunity. The mathematics and mathematics education community has established productive working relationships both among our own organizations and with many groups outside our community. We have a consensus and a strategy to improve mathematics education at all levels. We have a set of standards that stands not only as the authoritative voice of mathematicians and mathematics teachers but which benefitted enormously from the advice and opinion of many diverse groups from all sectors, public and private.

What is this consensus about? Put in its simplest terms, that consensus has been about making mathematics learning more about thinking and engaging the intellect and less about memorizing; more a task for the mind than the test of rote memory. It is about mathematical power—the individual's abilities to explore, to conjecture, and reason logically, as well as the ability to use a variety of mathematical methods effectively to solve nonroutine problems. It is about mathematical power for all students. "All" means just that, every student, not just the few, the elite; it means that 100% can attain a level of mathematical power, not the 50% above the norm, not some arbitrary passing number of 70% or 80%.

The linchpin of reform is valid assessment. I am not using the word "valid" in some esoteric technical sense or to mean some "perfect" test instrument, whatever that might be. I am talking about something very simple and very easy to understand, something our public has the good sense to comprehend if they are given half a chance. It is simply this: an assessment is of no use at all if it does not measure the things that we value, the goals and objectives that we agree on. Standards and tests are not the same thing, but they must match. We set standards based on what is of worth today and tomorrow, and then we assess whether we are meeting **those** standards, not skills we needed in the past that are now obsolete.

Assessments must match the standards. I know full well that assessment items themselves can become the objectives of instruction, that what we test is usually what we teach, that if there is sufficient stick or carrot our instructional program can become obsessively test-driven. But that state of affairs is only pernicious in the absence of standards or when standards are updated but our tests fail to follow suit. That, unfortunately, is the state of affairs today, but it is remediable.

There is a growing distance between school math and real world math and there is a growing gap between the goals of today's reform in mathematics and our tests of student performance. Assessment that matches what we value, what will be of value to our students in their futures, is attainable. It is unlikely however, that it will look like the traditional single test. It is far more likely that we will need a diversity of methods and instruments, that assessment will be the convergence of information about student performance from multiple sources.

The source of the public's confusion about these issues is probably the grave misconception the public has about mathematics and how it is used. One of the biggest problems is the erroneous view that mathematics doesn't change. It is not static, but growing and changing, and our curricula and assessments must reflect these changes.

The challenges of developing assessments are formidable. Our first task is to capture in the assessments the dynamic quality of our vision of mathematics instruction as active problem solving. Recent experience with rich problem-solving activities has shown that there are diverse pools of ability that have not been tapped by testing nor nurtured by our instruction. Our tests have not recognized the multiplicity of ways mathematical talent manifests itself. We surely cannot afford this waste. As math ability is diverse, so must be our assessments.

The teacher's role in assessment is important. We too often leave out the teacher as an important source of information. The teacher is closest to student performance, observes it daily, assesses it constantly to make instructional decisions. Surely any sophisticated system of assessment has a place for this wealth of direct information.

Teachers have a wealth of collective wisdom about recognizing achievement and we should be listening to them. They should be involved in decisions about evaluation at all levels. Teachers tell me that assessment will not improve the system if it is designed and used solely to sort, label, and categorize students. If assessment helps motivate learning, that is fine, but it also should be used to provide feedback that will inform instructional practice and improve student progress. Test scores, teachers believe, have too rarely been of help to them. Teachers also want assessment to bear some relation to the things that make mathematics powerful in the world. If problems are solved regularly in the workplace by teams rather than individuals, how, they ask, should we assess team problem solving? If problem solvers in the real world use calculators and computers, shouldn't they be an integral part of performance assessment? Listen to your teachers, America.

Between setting standards and using matching assessments for accountability, much must happen in classrooms across the country. Teachers need our support in creating and delivering the kinds of instructional programs that enable students to reach the standards. They need greater opportunity for professional growth, they need technological tools, they need higher quality instructional materials, and they need the genuine support of the public for the change that must occur. Help your teachers, America.

Do we have the will? I have tried to set the stage for our deliberations here by not only pointing out some thorny issues but how propitious conditions are. We have a formidable challenge but an unprecedented opportunity. The task is doable. **Our** assessment, the test for us, is: Do we have the will?

■ ■ ■

PRINCIPLES AND GOALS FOR MATHEMATICS ASSESSMENT

Assessment practices alone did not cause the current state of affairs in mathematics education and student achievement, nor can different assessment practices alone improve the current status. Assessment is but one of many components of the educational infrastructure that must change if our mathematics education is to become world class. Successful reform of mathematics education requires that curriculum, instruction, and assessment be revitalized in tandem. This statement of principles and goals for mathematics assessment is to support the mathematics education community's work in orchestrating change in curriculum, instruction, and assessment in a simultaneous fashion.

Assessment is a multifaceted endeavor whose purpose is to provide information so that students, teachers, parents, school administrators, public officials, and the general public can make informed decisions. Information from mathematics assessments is used by:

- students, who make decisions about themselves as learners of mathematics;
- teachers, who make decisions about how to effectively instruct each student;
- parents, who make decisions about how to help their children develop mathematical abilities;
- school administrators, who make decisions about the effectiveness of mathematics programs in their schools;
- public policy makers, who make decisions about the best use of resources in developing and maintaining mathematics programs of the highest quality; and
- the public, which makes decisions about the effectiveness of (i) mathematics education systems and (ii) the policy makers, school administrators, and teachers who are responsible for those systems.

Improving the national capacity for better decision making regarding mathematics education requires not only new and improved assessments but also better understanding on the part of decision makers that:

- different information needs may require different assessments and that one assessment cannot serve all needs;
- multiple sources of information lead to better informed decisions;
- traditional tests of achievement are only incomplete measures of overall knowledge and capabilities; and
- potential unfairness to an individual or a specific group of people can result if decisions are based on assessment of performance without assessment of equity of opportunity to learn.

PRINCIPLES

The mathematics education community joins leaders in education, public policy, and the private sector to set national goals for mathematics assessment for the next decade. The goals are based on our commonly held beliefs about assessment that we state as principles for mathematics assessment:

- **The primary purpose of assessment is to improve learning and teaching.** Assessment is an integral part of the teaching-learning process. Whether with classroom assessment or external assessment, the process and result of assessment must inform and enhance the learning and teaching process rather than narrow or restrict it.

  Classroom assessment—the extensive repertoire of methods and techniques used by teachers—serves the information needs of students, teachers, and parents. Rich and highly detailed information about a student's strengths and weaknesses helps both a student and a teacher know which efforts are improving mathematical learning and which are not and what mathematics the student has learned as well as what is yet to be learned. The same information, coupled with the teacher's analyses for parents, can better inform parents about their child's progress in learning mathematics and how the parents can contribute to the development of their child's mathematical abilities.

  External assessment provides information for school administrators, public policy makers, and the public on the achievement of groups of students and on contextual factors (e.g., opportunity to learn), processes (e.g., instructional practices), and resources (e.g., materials and equipment) that relate to student learning. Only by examining relationships among input, process, and output variables can school administrators and public policy makers develop educational policy and direct resources that will most effectively improve learning and teaching.

- **The primary use of results of assessments is to promote the development of the talents of all people.** Perhaps more than any other school subject, mathematics is used to filter students out of educational opportunity. This must change. Mathematics assessments should be used to promote the development of mathematical abilities of all students, as well as the effectiveness of schools and mathematics programs in developing those abilities.

  Setting new and demanding standards for all students of all groups places the equity issue at the forefront of assessment reform. The impact of new assessments on any group of students must be determined before implementing new assessment programs, particularly if the assessment program will have high stakes for individuals or groups. To be fair to all, assessments must be sensitive to cultural, racial, and gender differences. There must be multiple ways to demonstrate mathematics achievement; no decision on a student's opportunity to learn or placement in mathematics should be based on a single assessment. Mathematics assessment must build bridges, not barriers, to opportunity for excellent instruction in the mathematics that is valued.

Scores and results of assessments are meaningful and valuable in developing human resources only if the assessments are used for the purpose for which they were designed and if the results are interpreted appropriately.

- **The content of assessments is derived from the consensus of the discipline.** One inevitable consequence of assessment is the importance users place on what is assessed—the content of the assessment. The mathematical content of assessments is a clear, powerful message to students, parents, and teachers about what mathematics it is important to know and be able to do. It is essential, therefore, that the mathematical content of assessments reflect the best judgment of the professional community of mathematics educators and mathematicians.

  The quality of assessments is defined by how well they measure the **valued** mathematical knowledge, skills, and processes. At this point in the reform of mathematics education, the valued mathematics is defined in the NCTM's *Curriculum and Evaluation Standards for School Mathematics*. As the mathematical needs of society change, so should the nation's curriculum standards and the assessments that measure them. The nation cannot afford another episode of rigid adherence to mathematics programs that served the needs of the past but not of the present and foreseeable future.

GOALS

We have set the following goals for mathematics assessment to be reached by the year 2000:

- **Assessments will be aligned with the mathematical knowledge, skills, and processes that the nation needs all of its students to know and be able to do.** The assessments with which the nation judges the mathematics achievement of its youth must measure the mathematics that the nation needs for its youth. Furthermore, there must be broad-based professional, political, and public consensus on what mathematics is valued and therefore assessed.

- **Assessment practices will promote the development of mathematical power for all students.** The nation needs all its citizens to become mathematically literate, especially females and members of minority groups who have traditionally been underserved in mathematics programs. Assessments must be sensitive to diverse learning environments. Assessments that merely rank, classify, or sort do little to inform the learning-teaching process.

- **A variety of effective assessment methods will be used to evaluate outcomes of mathematics education.** The multiple outcomes expected of a world-class mathematics education cannot be adequately assessed with multiple-choice tests; different assessment methods are needed. Those methods should include open-ended problems, performance tasks, projects, investigations,

demonstrations, essays, portfolios, group work, interviews, and teacher observations. The research, development, and piloting of a variety of methods must involve mathematics teachers as well as measurement specialists, test developers, and mathematics specialists.

- **Adequate accountability systems will be used to assess mathematics.** Proper assessment requires multiple measures and indicators of many aspects of the nation's mathematics education systems. These aspects include student achievement; equity of opportunity to learn; quality of curricula and instructional practices; attitudes and expectations of students, parents, and teachers; qualifications of the teaching force; and availability of high-quality instructional materials and equipment. Only with an accountability system that yields all such information can the public make good judgments on how well school officials and public policy makers are providing mathematics programs for the nation's youth.

- **Guidelines will be developed for judging the quality of all forms of mathematics assessments.** Those who select, administer, and use results of mathematics assessment need to have some means of judging the quality of a given mathematics assessment. Guidelines can assure decision makers—students, teachers, parents, school administrators, public officials, and citizens—that the information produced by the assessment is useful and appropriate for their purposes.

- **Mathematics teachers and school administrators will be proficient in using a wide variety of assessment methods for improving the learning and teaching of mathematics.** Teachers and administrators will need staff development opportunities to expand their knowledge about a wide variety of assessment methods and to hone their skill in using assessment results to improve mathematics learning and teaching. In both preservice and in-service programs, faculty and staff of colleges and universities will be pivotal in this major staff development effort.

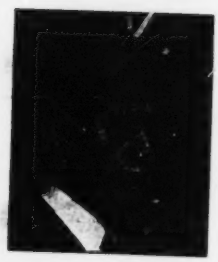
- **The public will become better informed about assessments and assessment practices.** To use assessment information wisely, the public must understand the various purposes of mathematics assessments and the meaning that can be attached to their results. The public must become critical consumers of assessment information, recognizing and challenging the questionable practice of using assessments for purposes for which they were not designed.

■ ■ ■

The President's Challenge

Excerpts of Summit Address by President Bush

Thank you all. Let me just say how pleased I am to be here. I salute Dr. Bromley, who is doing an outstanding job coordinating the science work for the White House and taking a leadership role in many of the most important issues of our day. And, of course, I salute Lamar Alexander. We announced the America 2000 just last week and we want your support and your ideas in terms of fulfilling our objectives for the America 2000 strategy.



"I salute the Mathematical Sciences Education Board for this conference, the National Education Goals Panel for conducting this forum, and, above all, I thank the educators and policy makers assembled here."

President George Bush

Your purpose here concerns our nation's future. Of the six national education goals we established with the nation's governors in Charlottesville, you're helping to realize one of the most ambitious —that American students be first in the world in math and science achievement by the year 2000.

This challenging goal, worthy of a great nation and its future ambitions, plays an important role in our America 2000 strategy to reinvent the American school. We can't expect kids to meet the test of worldwide competition unless we first establish world-class standards that define the knowledge and skills we expect students to learn and master.

Once we've set standards, we must assess our progress in meeting them. I salute the Mathematical Sciences Education Board for this conference, the National Education Goals Panel for conducting this forum, and, above all, I thank the educators and policy makers assembled here. You've labored for years to reach consensus on standards for mathematical skills and performance, and I commend you for your commitment and for your achievement. We can't blaze a trail to the future until we know where we stand.

The voluntary American Achievement Tests, a cornerstone of the America 2000 strategy, will measure achievement in five core subjects, including, obviously, mathematics. I've challenged the nation to have a test ready for the fourth graders of 1993 and to produce tests for eighth and twelfth graders soon after.

I ask each of you to help the public understand the purposes of standards and assessments, and to make sure that our achievement tests motivate and inspire students. Let's also ensure that these tests motivate and inspire the schools; that they make schools more accountable to the people they serve; and that they restore the kind of competition and pride that's essential for educational excellence.

We also must improve training for precollege math and science teachers. We need to attract more women and minorities into science and technology. The budget that we sent to Congress this year calls for a 13 percent increase in math and science education spending—a total of nearly $2 billion. But please understand that the federal government can play only a limited role in making America's students the first in math and science. Dollars alone won't get the job done. Real excellence demands a commitment from us all to reinvent the American school and achieve our ambitious national education goals.

As you consider your principles, goals, and actions for math assessment, let me ask you to keep a few questions in mind. Consider what it means to be the best in the world and what kind of balance our students will need between theoretical math and practical applied skills for life. How can we create tests to ensure not just that our best students are as good as any in the world but that our average students achieve world-class status? How can we emphasize testing that encourages better teaching and that doesn't weed kids out but develops better math skills for all?

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Many of you have already led the way. Consider one member of today's audience. Larry Williams, a math teacher at Eutaw High School in rural Alabama and a member of the Mathematical Sciences Education Board, has lit a fire under his students, many of whom come from poor or disadvantaged homes. His math teams can compete with any other team in Alabama and throughout the Southeast. When people ask how America can become first in the world in math and science by the year 2000, I point to teachers like Larry Williams—dedicated professionals who help all our children reach their potential.

All of you help set off an American educational renaissance, and I thank you for what you've done and for what you will achieve. I came here to tell you and to pledge once again to our Secretary of Education that we at the White House will do our level best to back you every inch of the way.

■ ■ ■

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Our Challenge

Beginning Assessment Reform

In addition to arriving at principles and goals for mathematics assessment, Summit participants discussed a variety of current assessment reform activities taking place across the nation.

- Representatives of states in which vigorous new approaches to mathematics assessment are under way described those state assessment programs in which mathematics assessments have been aligned to new state curriculum based on the NCTM curriculum standards.
- The National Education Goals Panel reported on alternative proposals it had under consideration for a system of national examinations to assess progress in achieving the national goals for mathematics set by President Bush and the nation's governors.
- Secretary of Education Lamar Alexander presented the president's education strategy, America 2000, that calls for Americans to create standards in each of the core disciplines and then to develop American Achievement Tests based on those standards.
- President Bush addressed the Summit and called on the mathematics education community to develop assessments for fourth-grade mathematics by 1993 and for eighth and twelfth grades soon thereafter.

"Whether or not the rank ordering of the United States is first by the year 2000, the most important thing will be whether by 2000 the United States is providing strong opportunity for all students to achieve results which are comparable with those students of our major trading partners . . . "

Gordon Ambach
Executive Director, Council of Chief State School Officers

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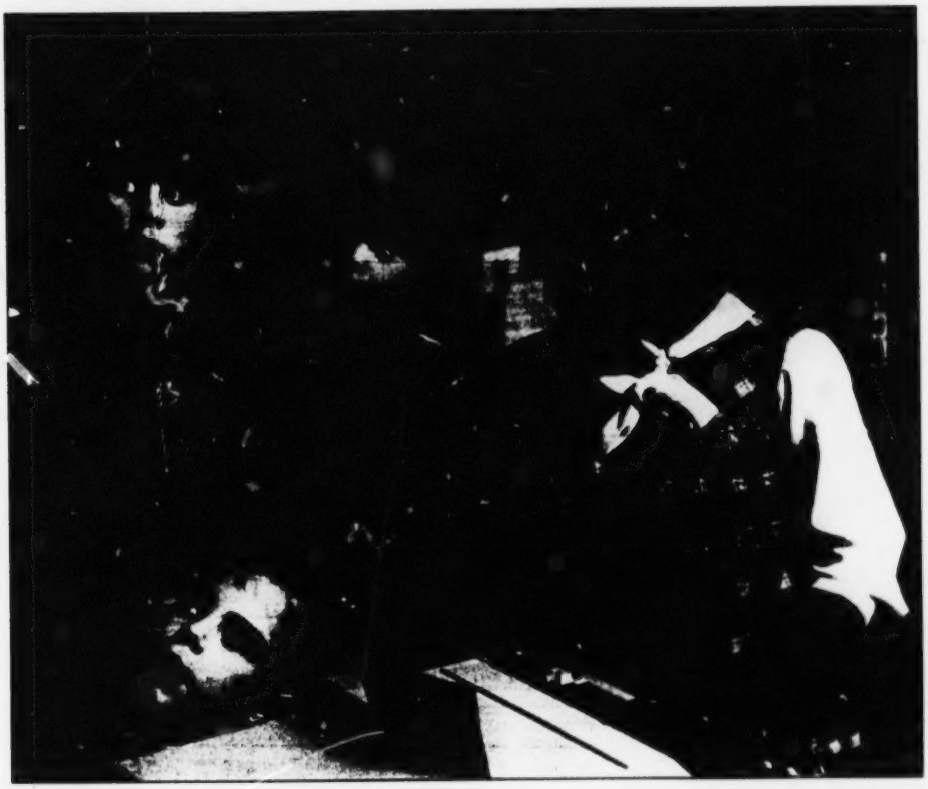

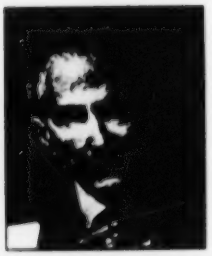

"I think it's terrific that the National Academy of Sciences and the mathematics community have provided . . . one of the leading edges, certainly, for education reform at this time."

David Hamburg
President, Carnegie Corporation of New York

Continuing the Collaboration

The challenge presented to the Summit participants and the groups and organizations they represent is to act now to achieve the national goals for mathematics assessment agreed upon at the Summit and to meet President Bush's challenge. Participants agreed that as important as action by an individual or a single organization is, the most critical activity will be that of the diverse constituencies working together to:

- develop national assessment standards for mathematics;
- inform the national debate on how best to measure progress toward achieving the ambitious national goals in mathematics education set by the president and the governors; and
- support teachers, schools, districts, and states in the reform of mathematics assessment.

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The Nation's Plan for Mathematics Reform

"[We] are concerned now with the problems of developing . . . and enhancing the scientific workplace and a technically and mathematically literate society."

Walter Massey
Director, National Science Foundation

By the Year 2000

The goals are clear: U.S. mathematics education must become the best in the world and our students must be first in the world in mathematics achievement. Nothing less will be adequate to fulfill American aspirations.

The national standards for school mathematics provide a clear vision for the learning and teaching of mathematics—a vision of equity and excellence. All of our students can and must learn mathematics for living and working in a world increasingly shaped by mathematics, science, and technology.

Beyond Goals and Standards

Goals and standards are the foundation on which to base the nation's plan for restructuring mathematics education. Support structures—the mechanisms and resources necessary for teachers to get the job done at the local level—must also be strengthened. Furthermore, in addition to facilities, equipment and materials, staff development, and administrative support, teachers need a working environment that enables them to do a first-class professional job.

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Combining School Restructuring with Discipline-Based Reform

Today's school environment is a product of a structure designed for the industrial age, a structure that is proving unsuitable for educating children for the information age. This is a reality that frustrates mathematics education reform and the reality that drives the school restructuring movement.

In the restructuring of schools, changes in the disciplines—what is taught and how—are related to changes in how schools are operated and held accountable. In the case of mathematics assessment, changes in both what is assessed and how it is assessed are related to how schools should be held accountable for their mathematics programs and for the mathematics achievement of their students.

A Call for Collaborative Action

Assessment is clearly an issue that requires the collaboration of all with interests in restructuring education and in revitalizing mathematics education. It is the hope of the Mathematical Sciences Education Board that the constituencies that joined the mathematics education community to improve mathematics assessment will continue to collaborate on building the support structures teachers need to make U.S. mathematics education world class.

"I think maybe we're not as optimistic as we ought to be about the potential power of the standards all by themselves."

Emerson Elliott
Acting Commissioner, National Center for Education Statistics U.S. Department of Education

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National Summit on Mathematics Assessment Steering Committee

"A remarkable group of individuals served on the Steering Committee for the National Summit on Mathematics Assessment, helping the mathematics community achieve its reform agenda and assisting the nation as it strives to meet Goal Four of the National Education Goals—first in the world in science and mathematics achievemnt by the year 2000."

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Chair, MSEB

The Honorable Lamar Alexander, Chairman
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